

### **REMARKS**

The present invention is an antenna comprising an element as defined on lines 23-25 of page 1 of the specification in the Summary of the Invention. An example of the element is illustrated in Fig. 3. The element is formed from conductor patterns 42 on a plurality of layers of a multilayer PCB 40. The conductor patterns are in a stacked relation and interconnected through the PCB by vias 52.

Claims 1-4, 9-12, 17-20 and 25-28 stand rejected under 35 U.S.C. §102(e) as being anticipated by United States Patent 6,348,892 (Annamaa et al). Specifically, the Examiner reasons as follows:

Regarding these claims, Annamaa et al show an antenna for a portable phone in Fig.1,2 and 4-7 where the antenna is formed on the edge of a multiplayer PCB 570,550,540 above a ground plane and connected through the layers thereof with vias 502,503 and 504 from the antenna520,530560 to the ground plane 510, all arranged as claimed.

This ground of rejection is traversed for the following reasons.

As the Examiner is aware, an anticipation rejection requires that every limitation of the claims must be explicitly present in the cited reference or inherent therein. In this case, it is noted that the Examiner is not relying upon inherency.

There are three principle differences between the subject matter of independent claim 1 and that of Annamaa et al. First, Annamaa et al relies upon a multi element configuration as the term element is described in the specification of the present invention and as used in the claims. The Examiner should note the description of the embodiments of Annamaa et al Fig. 3, Fig. 4a, Fig. 5a and Fig. 6 all refer to multiple elements whereas the claims are limited to "the element". Accordingly, the recitation in claim 1 of

"the element..." is not met in view of Annamaa et al teaching multiple elements.

Additionally, while Annamaa et al do teach a configuration of conductive layers separated by dielectric layers, it is submitted that a person of ordinary skill in the art would not consider the disclosed structure to be a multilayer PCB.

Finally, claim 1 recites an interconnection through the multilayer PCB of the conductor patterns which are in stacked relation. While conductors between layers are depicted in Figs. 4b, 5b and 6b of Annamaa et al, these conductors do not read upon the interconnection through the PCB for the reasons that the insulated conductive layers of Annamaa et al do not constitute a PCB.

There is no basis in the record why a person of ordinary skill in the art would be led to modify Annamaa et al to arrive at the subject matter of the rejected claims. The aforementioned three differences are not obvious modifications of Annamaa et al.

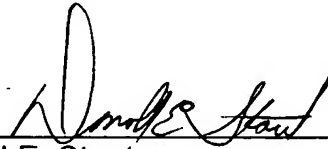
Dependent claims 2-4, 9-12, 17-20 and 25-28 define more specific aspects of the present invention which are neither anticipated nor rendered obvious by Annamaa et al. There is no basis why a person of ordinary skill in the art would be motivated to modify Annamaa et al to arrive at the subject matter of independent claim 1 and dependent claims 2-3, 9-12, 17-20 and 25-28 except by resort to impermissible hindsight.

In view of the foregoing amendments and remarks, it is submitted that the application is in condition for allowance. Accordingly, early allowance thereof is respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 C.F.R. §1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account No. 01-2135 (1076.41311X00) and please credit any excess fees to such Deposit Account.

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP

A handwritten signature in black ink, appearing to read "Donald E. Stout", is written over a horizontal line.

Donald E. Stout  
Registration No. 26,422  
(703) 312-6600

Attachments

DES:dlh



1076.41311X00  
07 40576

## SUBSTITUTE SPECIFICATION

### **Multilayer PCB Antenna**

#### BACKGROUND OF THE INVENTION

##### **Field of the Invention**

[0001] The present invention relates to PCB antennas.

##### **~~Background to the Invention~~**

##### **Description of the Prior Art**

[0002] Bluetooth is a short range wireless networking system operating in the ISM 2.4GHz band. The development of Bluetooth has required designers of disparate electronic devices to include rf circuitry for the first time and, in the case of mobile phones, additional rf circuitry. This of course can lead to undesirable increases in the size of devices to accommodate the electronics and the antenna or antennas required.

[0003] PCB antennas are disclosed in DE-U-29701 589, GB-A-2237451 and US-A-5898404. However, in each of these documents the elements are formed from single layers of conductor.

##### **Summary of the Invention**

##### **SUMMARY OF THE INVENTION**

[0004] An antenna according to the present invention is characterised characterized in that said the element is formed from conductor patterns on a

plurality of layers of a multilayer PCB, wherein the conductor patterns are in stacked relation and interconnected through the PCB.

**[0005]** The term “element” is not used herein as a generic reference to any structure but is used with the sense normally given in the field of antennas, for example in phrases such as “2-element Yagi” and “parasitic element”.

**[0006]** Preferably, the element is located at the edge of the PCB. This reduces the amount of lossy PCB material in the vicinity of the antenna, Additionally or alternatively, the PCB may be apertured adjacent to the element. This also reduces the amount of lossy PCB material in the vicinity of the antenna.

**[0007]** The present invention may be embodied in an inverted-F antenna comprising an F-shaped conductor pattern on a first layer of the PCB and an I-, L- or F-shaped conductor pattern on the or each other layer, wherein the or each I-shaped conductor pattern is substantially coextensive with the “upright” of the F-shaped conductor pattern.

**[0008]** Preferably, the or each I-, L- or F-shaped conductor pattern extends along the edge of the PCB.

**[0009]** Preferably, the PCB is apertured, e.g. for example, by means of a slot, between the “upright” of the F-shaped conductor pattern and a ground plane area.

**[0010]** An antenna ground plane may be provided by a plurality of vias connecting ground plane regions on respective PCB layers.

**[0011]** An antenna according to the present invention may be employed in a mobile phone.

**~~Brief Description of the Drawings~~**  
**BRIEF DESCRIPTION OF THE DRAWINGS**

**[0012]** Figure 1 is a block diagram of a mobile phone including an antenna according to the present invention;

**[0013]** Figure 2 illustrates the arrangement of an antenna according to the present invention on the main PCB of the mobile phone of Figure 1; and

**[0014]** Figure 3 is an exploded view of the antenna of Figure 2.

**~~Detailed Description of the Preferred Embodiment~~**  
**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

**[0015]** An embodiment of the present invention will now be described, by way of example, with reference the accompanying drawings.

**[0016]** Referring to Figure 1, a mobile telephone comprises an antenna 1, an rf subsystem 2, a baseband DSP (digital signal processing) subsystem 3, an analogue audio subsystem 4, a loudspeaker 5, a microphone 6, a controller 7, a liquid crystal display 8, a keypad 9, memory 10, a battery 11, a power supply circuit 12, a Bluetooth transceiver 13 and a Bluetooth antenna 14.

**[0017]** The rf subsystem 2 contains if and rf circuits of the mobile telephone's transmitter and receiver and a frequency synthesizer for tuning the mobile telephone's transmitter and receiver. The antenna 1 is coupled to the rf subsystem 2 for the reception and transmission of radio waves.

**[0018]** The baseband DSP subsystem 3 is coupled to the rf subsystem 2 to receive baseband signals therefrom and for sending baseband modulation signals thereto. The baseband DSP subsystems 3 includes codec functions which are well-known in the art.

**[0019]** The analogue audio subsystem 4 is coupled to the baseband DSP subsystem 3 and receives demodulated audio therefrom. The analogue audio subsystem 4 amplifies the demodulated audio and applies it to the loudspeaker 5. Acoustic signals, detected by the microphone 6, are pre-amplified by the analogue audio subsystem 4 and sent to the baseband DSP subsystem 4 for coding.

**[0020]** The controller 7 controls the operation of the mobile telephone. It is coupled to the rf subsystem 2 for supplying tuning instructions to the frequency synthesizer and to the baseband DSP subsystem for supplying control data and management data for transmission. The controller 7 operates according to a program stored in the memory 10. The memory 10 is shown separately from the controller 7. However, it may be integrated with the controller 7. A timer for triggering interrupts is also provided by the controller 7.

**[0021]** The display device 8 is connected to the controller 7 for receiving control data and the keypad 9 is connected to the controller 7 for supplying user input data signals thereto. Amongst other function, the display device displays the estimated extant life of the battery 11 by

**[0022]** The battery 11 is connected to the power supply circuit 12 which provides regulated power at the various voltages used by the components of the mobile telephone. The positive terminal of the battery 11 is connected to an analogue-to-digital converter (ADC) input of the controller 7.

**[0023]** The Bluetooth transceiver 13 is controlled by the controller 7 and sends and receives signals via the Bluetooth antenna 14.

**[0024]** Referring to Figure 2, the PCB 40 of the mobile phone has an upper end on which the loudspeaker 5 is mounted. The display 8 is mounted below the loudspeaker 5 and below the display is the keypad 9. The Bluetooth antenna 14 comprises an inverted-F antenna formed in a small strip-shaped region to the side of the keypad 9.

**[0025]** Referring also to Figure 3, the PCB 40 has first to eighth layers 40a, ..., 40h (shown with exaggerated thickness). The layers 40a, ..., 40h have respective ground plane areas 41a, ..., 41h. The ground planes 41a, ..., 41h are partially removed at the edges of the layers 40a, ..., 40h. However, an F-shaped region 42 of conductor is left on the first layer 40a. The "upright" of the F-shaped region 42 runs along the very edge of the first layer 40a with the "arms" directed inwards towards the ground plane 41a. Only the upper "arm" actually joins the ground plane 41a.

**[0026]** On the second to eighth layers 40b, ..., 40h, an I-shaped region 43b, ..., 43h of conductor is left along the edge under the "upright" of the F-shaped region 42 and coextensive therewith. The eighth layer 40h may be double sided and also have an I-shaped region on its other side.

**[0027]** The fourth layer 40d includes the feed 46 to the antenna which extends to a point under the shorter "arm" of the F-shaped region 42.

**[0028]** The "upright" of the F-shaped region 42 and the I-shaped regions 43b, ..., 43h are connected by a plurality of vias 52. This unites these regions which collectively form the radiating element of the Bluetooth antenna 14. Similarly, the feed 46 is connected to the shorter "arm" of the F-shaped region 42 by a via 47. A row of vias 51 unites the edges of the ground plane areas 41a, ..., 41h, which are substantially parallel to the "upright" of the F-shaped region 42, to form a ground plane for the antenna.



**[0029]** In order to reduce losses, two slots 48, are cut through the full thickness of the PCB 40. The slots 48 are located so that they are between the “upright” of the F-shaped region 42 and the ground plane on the first layer 40a, and extend parallel to the “upright” of the F-shaped region 42.

**[0030]** It will be appreciated that many modifications may be made to the above-described embodiment. For example, the I-shaped regions could be replaced with L-shaped regions which match the “upright” and upper arm parts of the F-shaped region or further F-shaped regions.

**[0031]** The antenna may be formed using other multilayer PCB structures, for instance three double-sided PCB layers (i.e. copper on both faces) may form the second to seventh layers of the antenna with single-sided PCB being used to form the first and eighth antenna layers.

**[0032]** Other forms of antenna, e.g. for example resonant dipoles, can be formed in a similar manner. Furthermore, multi-element antennas may be formed if directivity is a desirable characteristic. Additionally, a plurality of antennas may be formed on the same PCB or in the same way on different PCBs to provide path diversity, directivity or omnidirectivity as desired.

## **Abstract**

An antenna is formed at the edge of a multilayer PCB. An element of the antenna consists of foil pattern elements on a plurality of layers of the PCB connected by vias.